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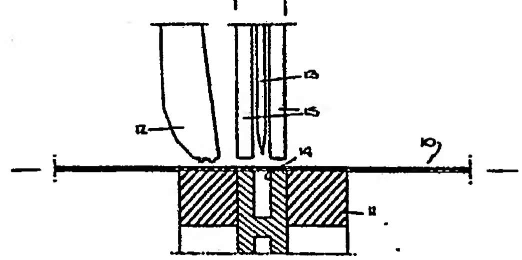
(54) **A process for cutting and perforating plastic film.**

(57) A process is disclosed for cutting or perforating a plastic film sheet material with a knife of improved durability which comprises a metal substrate coated on one side only with a hard material such as tungsten carbide. A preferred embodiment comprises a process for making a continuous strip of interconnected and separable plastic film bags of low pressure - low density polyethylene from a tube of same including the steps of sealing the tube across its width at longitudinally-spaced intervals and perforating the tube at similar intervals, to provide tear-off lines, with a perforating blade provided with a coating on one side only of a hard material such as tungsten carbide. Such a perforating blade has a significantly improved service life, as compared to uncoated similar blades or similar blades coated on both sides, in processes for making bags from low pressure-low density polyethylene.

Fig.1



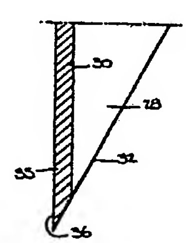


Fig.6

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Croydon Printing Company Ltd.

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a process for cutting or perforating sheets of plastic film material, especially as part of a process for making flexible plastic film packaging materials. More particularly, the invention relates to a process for making plastic film packaging bags and in a preferred embodiment, to a process for making continuous strips of interconnected, but separable, plastic film packaging bags including the step of perforating the plastic film material with a perforating blade having improved service durability. The present invention is especially useful in making packaging bags composed of low pressure-low density polyethylene film.

Description of the Prior Art

Processes and equipment for making plastic film wrapping sheets and bags in continuous strips, and providing tear-off lines for one at a time removal of the individual wrapping units, have been well-known in the prior art and commercially available. A known process for forming continuous and interconnected but separable plastic film packaging bags includes the steps of extruding a tube of plastic film material, such as polyethylene, by a tubular blown film extrusion process and advancing the tube through a bag-making machine wherein the advancing tubular film material is heat-sealed across its width at spaced longitudinal intervals and perforated across its width at the same intervals to allow

later separation into individual bags. The resulting plastic bags have a variety of packaging uses, such as for garments, trash, produce, meat, and the like. In most cases, the bag-making machine (such as those available from Gloucester Engineering Co.) is provided with shuttling means to momentarily stop the tube advance for the sealing and perforating operations; however, apparatus is also known which travels along with the advancing tube to seal and perforate same without the necessity of momentarily stopping the tube advance. The resulting continuous strip of interconnected and separable plastic bags may be rolled for dispensing later or the bags may be separated and stacked by methods and apparatus known in the art. Single-ply plastic film wrapping sheets, in continuous strips of interconnected and separable sheets or separated sheets, may be made by a similar process by starting with a single layer of plastic film or sheet material.

The perforating is usually performed by forcing a serrated-type blade through the plastic film tube. Such perforating blades are commercially available in various configurations and are typically composed of a flat steel body having teeth along one edge thereof. The configuration of the teeth depends, in part, on the type and size of bag being made and the plastic film material of which it is formed. Those skilled in the art are well aware of the considerations governing the selection of a perforating blade for such applications. As an example, in a process for making low density polyethylene produce bags in a Gloucester Engineering Model 418 bag machine, a 10-inch long perforating blade composed of No. 1095 carbon steel and having 40 teeth along one

edge thereof, may be employed. Each tooth is chamfered on one side as a result of a sharpening operation to thereby provide a cutting edge.

Such plastic film packaging bags and sheets have been made of various types of thermoplastic film materials, including low- and high-density polyethylene, polypropylene and the like. However, low density polyethylene is perhaps the most important of the thermoplastic packaging films, accounting for a significant portion of the total usage of such films in packaging. Low density polyethylene possesses a unique combination of properties essential for broad end use utility and wide commercial acceptance in the packaging field. These properties include film optical quality, mechanical strength properties (such as puncture resistance, tensile strength, impact strength, stiffness and tear resistance), vapor transmission and gas permeability characteristics and performance in film converting and packaging equipment.

In processes for preparing, for example, low density polyethylene bags, employing polyethylene made by the conventional high pressure process, the expected service life of a perforating blade may be on the order of 2 to 4 weeks. However, it has been found that when preparing low density polyethylene bags by the same type of process, where the polyethylene is made by the so-called low pressure process, the service life of the perforating blade was reduced to a matter of hours. In such a case it may be necessary to close down an entire commercial line to change perforating blades at frequent intervals or the resulting

product may become unsuitable due to poor quality perforations. Either situation provides a totally unacceptable commerical process.

Since low pressure-low density polyethylene film is tougher than the corresponding high pressure material, it was postulated that the cutting edges of the reduced-life perforating blade were wearing. However, in one instance, after a blade was no longer acceptable for perforating low pressure-low density polyethylene film, it was found that it was nevertheless still useful in perforating conventional high pressure-low density polyethylene for an additional period of time of about 3 weeks. It was also found that cutting edges coated on both sides with a hard material did not significantly extend the useful service life of a perforating blade in a process for making low pressure-low density polyethylene film bags.

The prior art teaches various types and shapes of cutting devices in various applications. For example, U.S. Patent No. 4,064,776 discloses a method and apparatus for making tear-resistant, separable end-connected plastic film bags utilizing a perforating blade which is serrated in shape and which is provided along its length with deep recesses beyond the cutting edge to define connecting tabs between the perforations across the width of the advancing film material. The blade is also heated to effect annealing of the perforation edges.

U.S . Patent No. 4,161,382 discloses an apparatus for making containers from thermoplastic sheet material, including a cutting blade having at least one cutting edge

extending vertically at an oblique angle to the surfaces to be cut, wherein slots in the sheet are formed when the blade is moved vertically into the sheet material.

It is also known in the prior art that the durability of various types of cutting blades can be increased by providing a coating of an extremely hard material such as tungsten carbide on one side of the cutting edge. The prior art discloses that this may be due in part to the fact that since the tungsten carbide coating is significantly harder than the substrate onto which it is coated, more and more of the tungsten carbide coating is exposed as the softer substrate is worn away during use, thereby presenting a sharper cutting edge for longer periods of time. This self-sharpening effect of one-sided coating has been recognized for use in cutting devices such as household knives, paper cutting and trimming knives and other types of beveled disk knives.

U.S. Patent No. 3,975,891 discloses a rotary mower blade made of outer layers of metal having an inner layer of extremely hard material and shaped such that attrition in use of the outer metal layers exposes the inner extremely hard material to maintain a sharp cutting edge. It is disclosed that a fine cutting edge is formed and maintained as a result of the wearing of the blade, instead of the blade becoming more dull by such wear.

Other one-sided coated cutting instruments are disclosed in the prior art. For example, U.S. Patent No. 3,618,654 discloses a blade for cutting plastic material such as tire stock, having a body of steel with a flat backing surface and a channel in one edge thereof which contains

a ring of tungsten carbide to be ground flush with the steel body on one side and projecting outwardly so that it is exposed on both sides and terminates in a cutting edge. U.S. Patent No. 2,634,499 discloses a similar cutting edge, comprised of a piece of tungsten carbide bonded to a substrate and designed for cutting materials such as asphalt roofing and other abrasive compositions.

U.S. Patent No. 3,988,955 discloses a band saw blade comprising a steel body having a plurality of teeth spaced along one edge thereof. The tip of each tooth is coated with a hard carbide material and then impulse hardened. The coating overlaps both sides of the cutting edge.

SUMMARY OF THE INVENTION

In its broadest aspects, the present invention comprises an improved process for cutting or perforating a plastic film sheet material employing a cutting or perforating blade which exhibits improved service life durability, the blade being composed of a metal substrate having a coating of a hard material on only one side thereof. More specifically, and in a preferred embodiment, a process for making a continuous strip of interconnected and separable plastic film bags is provided which includes the steps of providing, such as by tubular blown film extrusion, a tube of plastic film material and sealing and perforating the tube across its width at spaced longitudinal intervals, wherein the perforating is accomplished with a blade coated on one side only with a hard material such as tungsten carbide. The process is especially useful in the manufacture of continuous strips of interconnected but separable bags of

low pressure-low density polyethylene film, employing a serrated metal perforating blade which is beveled or chamfered on one side only and whose flat side only is coated with a hard substance such as tungsten carbide. In such a process, these blades exhibit a significantly improved service life as compared to uncoated similar blades or similar blades coated on both sides.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a schematic illustration of a vertical stroke heat-sealing and perforating apparatus which may be used in a process for making continuous strips of interconnected but separable plastic film bags.

Figure 2 is an enlarged plan view of the teeth area of a serrated and slotted metal perforating blade.

Figure 3 is an enlarged plan view of the teeth area of a serrated, unslotted metal perforating blade.

Figure 4 is an enlarged side view of one of the teeth of the perforating blade of Figure 3.

Figure 5 shows the blade tooth of Figure 4 with a coating on the flat side thereof in accordance with the invention.

Figure 6 is an enlarged view of the tip area of the blade of Figure 5.

Figure 7 is a view illustrating the tip of Figure 6 after some wear has occurred in use.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Although the process of the present invention has particular utility in a process for cutting or perforating film sheets of low pressure-low density polyethylene, it is expected to be useful in cutting or perforating many different types of plastic materials, including conventional high pressure-low density polyethylene, high density polyethylene, polypropylene, polyvinyl chloride and the like. In addition, the invention is expected to be useful in cutting or perforating paper or paper-like sheets.

As is known by those skilled in the art, low density polyethylene typically has a density of about 0.94 g/cc or lower while high density polyethylene has a density of above about 0.94 g/cc. Conventional low density polyethylene has in the past been made commercially by the high pressure (i.e., at pressures of 15,000 psi and higher) homopolymerization of ethylene in stirred and elongated tubular reactors in the absence of solvents using free radical initiators. Recently, a low pressure process for preparing low density polyethylene has been developed which has significant advantages as compared to the conventional high pressure process. One such low pressure process is disclosed in commonly-assigned, copending U.S. Applications Serial No. 12,720, filed February 16, 1979 and Serial No. 892,322, filed March 31, 1978 (a foreign-filed application corresponding thereto has been published as European Patent Publication No. 4647).

The above-identified copending application discloses a low pressure gas phase process for producing low density ethylene copolymers having a wide density range of about 0.91 to about 0.94 g/cc and a melt flow ratio of from about 22 to about 36 and which have a relatively low residual catalyst content and a relatively high bulk density. The process comprises copolymerizing ethylene with one or more C_3 to C_8 alpha-olefins in the presence of a high activity magnesium-titanium complex catalyst prepared under specific activation conditions with an organo aluminum compound and impregnated in a porous inert carrier material. The copolymers thus prepared are copolymers of predominantly (at least about 90 mole percent) ethylene and a minor portion (not more than 10 mole percent) of one or more C_3 to C_8 alpha olefins which should not contain any branching on any of their carbon atoms which is closer than the fourth carbon atom. Examples of such alpha-olefins are propylene, butene-1, hexene-1, 4-methyl pentene-1 and octene-1.

The catalyst may be prepared by first preparing a precursor composition from a titanium compound (e.g., $TiCl_4$), a magnesium compound (e.g., $MgCl_2$) and an electron donor compound (e.g., tetrahydrofuran) by, for example, dissolving the titanium and magnesium compounds in the electron donor compound and isolating the precursor by crystallization. A porous inert carrier (such as silica) is then impregnated with the precursor such as by dissolving the precursor in the electron donor compound, admixing the support with the dissolved precursor followed by drying to remove the solvent. The

resulting impregnated support may be activated by treatment with an activator compound (e.g., triethyl aluminum).

The polymerization process may be conducted by contacting the monomers, in the gas phase, such as in a fluidized bed, with the activated catalyst at a temperature of about 30 to 105°C and a low pressure of up to about 1000 psi (e.g., from about 150 to 350 psi). The resulting low density ethylene copolymers may be formed into thin film having improved puncture resistance, high ultimate elongation, low thermal shrinkage and outstanding tensile impact strength, by extrusion through an extrusion die having a gap of greater than about 50 mils. One such process is disclosed in commonly-assigned, copending U.S. Applications Serial No. 12,795, filed February 16, 1979 and Serial No. 892,324, filed March 31, 1978 (a foreign-filed application corresponding thereto has been published as European Patent Publication No. 6110). The film thus prepared may contain conventional additives and may have a thickness of about 0.1 mil to about 20 mils and may be formed into a tube by the tubular blown film extrusion process.

Although the present invention is applicable to any process for cutting or perforating plastic film sheet material, for purposes of convenience the invention will be described herein by reference to a process for making continuous strips of interconnected but separable plastic film packaging bags. It should be understood that it is not intended to limit the invention thereby; rather, it should be expressly understood that the invention is limited only by the scope of the claims appended hereto.

In addition, for ease of description only, the present invention will be described by reference to a process for making such bags composed of the presently-preferred material, low pressure-low density polyethylene, although it is to be understood that the invention is or is expected to be applicable to other materials such as conventional high pressure-low density homopolymers and copolymers of ethylene, high density homopolymers and copolymers of ethylene, homopolymers and copolymers of propylene, homopolymers and copolymers of vinyl chloride, paper and the like. For purposes of definition, by "low pressure-low density polyethylene" is meant ethylene polymers having a density of about 0.91 to about 0.94 such as the ethylene-C_3 to C_8 alpha olefin copolymers described above.

As indicated above, plastic film bag-making machinery and processes are commercially known and available. A typical process includes the steps of forming a plastic film tube by the tubular blown film extrusion process and advancing the plastic film tube in flattened form through a bag-making machine where the tube is heat-sealed across its width at spaced longitudinal intervals and perforated at similar intervals with a perforating knife to provide means for later separating the individual plastic film bags from the resulting continuous strip. Depending upon the type and size of the plastic film bags being manufactured, any known and commercially-available equipment can be employed. For example, to make garment-type bags which have a width of approximately 27 inches, Gloucester Engineering Company bag-making machines identified by Model Numbers 417 or 419 may be employed. For

smaller produce-type plastic film bags, Gloucester Model Numbers 418 or 425 may be used. All of these machines utilize a pair of rolls which shuttle back and forth to momentarily halt the advance of the plastic film tube through the bag-making machine and enable the heat-sealing and perforating operations to occur.

Most commercially-available bag-making machines employ perforating blades having a length of 10 inches, and 3 or more blades may be required across the width of the bag-making line. In those machines such as the garment bag-making type, which have a width of about 30 inches, only a single flattened tube of about the same width is fed through the machine. However, it is possible to feed one large tube into the bag-making machine and produce more than one line of bags simultaneously by conventional techniques. For example, a single large tube may be fed into a single machine to produce separate rolls of interconnected but separable bags, wherein the large tube is subjected to perforating and heat-sealing operations and then is slit-sealed longitudinally to provide several distinct rolls of bags. When it is desired to separate and stack such bags, starting from a single large plastic film tube, the operations are reversed; i.e. the large tube is first longitudinally slit-sealed followed by perforating and heat-sealing each of the resulting tubes. Conventional means, such as nip rolls driven at a speed greater than the tube advance speed in the machine, may be provided adjacent the exit of the bag-making machine to effect separation of the interconnected strips into individual bags.

Regardless of the type of bag-making machine employed, the process of the present invention includes the step of perforating a plastic film with a perforating knife of improved durability. The perforating operation is normally conducted by vertically stroking the perforating blade into and through the plastic film tube. Figure 1 of the attached drawings schematically illustrates a vertical stroke heat-sealing and perforating apparatus of a commercially available bag-making machine. Referring to Figure 1, a tubular film 10 is shown advancing right to left in the drawing over supporting means 11. Conventional means (not shown) may be provided for momentarily stopping the advance of the plastic film tube, at which time the heat-sealing and perforating operations can occur. These operations are normally performed simultaneously by vertically stroking a heat-sealing means 12 and perforating blade 13 downwardly as shown in Figure 1. A heat-seal is formed across the width of the flattened tube to provide a sealed bottom portion of a plastic bag. Simultaneously, the perforating blade 13 punctures the tubular film 10 by being forced through the film into slot 14. Stripper bars 15 are also stroked downwardly at the same time to hold film 10 in place during the perforation and to facilitate removal of the perforating blade from the tubular film during its upward stroke, as is conventional.

These sealing and perforating operations, in commercial processes, may be repeated at a rate of from about 10 to 170 times per minute. The cycle speed required of the perforating blade, of course, depends upon how rapidly the

plastic film tube is advancing through the bag-making machine. This, in turn, depends upon the size of the bags being made. It is apparent that for a given speed of advance, the rate of perforation is substantially less for long bags such as garment bags in comparison to produce bags where the perforations are much closer. Generally, in processes for making plastic film packaging bags, the plastic film tube may be advanced through the bag-making machine at a rate of about 10 to about 400 feet per minute or higher. Normally, the higher rates are for the longer bags such as garment bags. The typical rate of advance in a process for producing produce-type bags having a length of about 16 to 20 inches is about 150 to about 160 feet per minute, at which speed and for 16 inch-long produce bags, a perforating blade cycle of about 147 times per minute would be expected. Of course, the cycling time of the perforating blade may vary greatly depending upon how rapidly one wishes to advance the plastic film tube through the machine and upon the length of the bag being manufactured. Those skilled in the art are well aware of the controlling factors. Despite the particular speed of advance, as the cycling speed of the perforating blade increases, the wearing of the blade becomes more rapid and hence this additional factor must be balanced in determining the desired or optimum operating conditions. Those skilled in the art may determine the various conditions of operation given the desired results.

As the perforating blade exhibits wear and becomes dull, the plastic film may not perforate cleanly, which is undesirable since uneven elongated film areas surrounding

the perforation lines can lead to bag failure by premature tearing. The severity of this problem is influenced by the film gauge with the thinner gauge films presenting more problems than thicker films. The thickness of the plastic film bags may vary considerably depending upon the desired end use and particular plastic film employed. As an example, for low pressure-low density polyethylene, produce-type bags generally may have a film thickness of 0.0003 to 0.001 inch and garment-type bags may have a thickness of 0.0003 to 0.001 inch. It is obviously desirable to use a perforating blade having as long a life as possible since it is commercially unacceptable to shut down an entire bag-making line to replace blades at frequent intervals. It is also commercially disadvantageous to resharpen bag perforating blades if resharpening does not significantly extend their useful service life. The problem of the short life of conventional perforating blades, even those which have been resharpened, experienced in processes for making low pressure-low density polyethylene bags, is alleviated by using the perforating blade of the present invention.

A portion of a serrated perforating blade of the type which may be employed in the practice of the present invention is shown in Figure 2. As shown in Figure 2 a serrated blade 16 is composed of a main body portion 17 and a plurality of teeth 18 projecting outwardly therefrom along one edge thereof. Recesses or slots 19 are provided between adjacent teeth. Although the slots are shown as being rectangular in shape in Figure 2, they may take any form.

The edges of each tooth 18 are beveled such as by sharpening to provide chamfered faces 23 and 24 and cutting edges 20 and 21 (formed by the intersection of faces 23 and 24 and the flat side of each tooth 18).

Another type of perforating blade is shown in Figure 3. Specifically, Figure 3 illustrates a portion of the teeth area of an unslotted blade 25 which comprises a main body portion 26 provided along one edge thereof with a plurality of teeth 27. Each tooth 27 may be sharpened to provide chamfered faces 28 and 29 and cutting edges 30 and 31 formed by the intersection of the chamfered faces and the flat side of each tooth. This is shown in greater detail in Figure 4 which illustrates, in exaggerated form, the tip area of each tooth of the blade of Figure 3.

The particular shape of the perforating blade employed in the practice of the present invention is not critical. It may be slotted or unslotted and the number of teeth or slots in the blade may vary depending upon the particular material being treated, the sizes of the bag and perforations, the speed at which the plastic film material is moving through the apparatus, etc. Those skilled in the art are aware of the various blade configurations that can be employed for these purposes. Generally, any conventional type and configuration of perforating blade can be used in the practice of the present invention. It is preferred, however, for perforating low pressure-low density polyethylene, that the blade be unslotted of the type illustrated in Figure 3. As stated above, many commercial bag-making

machines are designed to accept one or more blades each ten inches in length. For unslotted blades of such length, best results for perforating low pressure-low density polyethylene have been obtained with blades having 40 teeth, although good results have also been obtained with blades having 27 or 50 teeth.

Slotted blades may also be employed in the present invention. Generally, any slotted blade of conventional configuration may be employed, such as those represented by Figure 2. It is not necessary that each tooth be separated by a slot from each adjacent tooth which is the conventional configuration. The dimensions of the slotted blades may vary depending on the nature of the material being perforated, the size of the bag being formed, the size of perforation desired, etc. As a general rule, when perforating low pressure-low density polyethylene, which is tough and tear-resistant, the width of each slot should not exceed about 0.030 inch. For conventional high pressure-low density polyethylene, the slot width may be on the order of 0.060 to 0.070 inch although when making garment bags of this material for example, slot widths up to about 0.125 inch may be tolerated. With either the slotted or unslotted blade, the thickness thereof may be determined based on the strength of the metal constituting the blade, its expected level of use, the size of perforation required, etc. A conventional perforating blade may be formed from a blank by machining and the teeth area is typically of a lesser thickness than the main body portion. Generally, for blades

formed of No. 1095 carbon steel, the thickness of the main body portion may be on the order of about 0.050 inch while the teeth may have a thickness on the order of about 0.010 to 0.015 inch. As is apparent to those skilled in the art, the dimensions of a perforating blade are not particularly critical and all of the foregoing dimensions may be varied depending on the circumstances.

The choice between a slotted and unslotted blade may depend on the degree of control desired or necessary in the bag-making machine. When using a slotted blade, such as in apparatus of the type shown in Figure 1, perforations are obtained as a result of forcing the blade through the plastic film at least as far as into the slot whose width predetermines the distance between perforations. When using an unslotted blade however, the depth of the perforation stroke must be carefully controlled to provide the desired or necessary distance between perforations. Despite the fact that finer control is therefore necessary with the unslotted blades, they offer an advantage over slotted blades in that there is more cutting edge along the length of the blade since there are no slots and therefore one may extend the useful life of an unslotted blade by suitable adjustments in the perforating stroke as the cutting edge dulls from wear (i.e., the stroke is controlled to force more of the teeth through the plastic film). Depending upon the need, the foregoing countervailing considerations may be weighed by those skilled in the art in the selection of a perforating blade configuration.

The materials of which the perforating blade may be made are not particularly critical. An advantage of the present invention is that a relatively softer blade material may be employed since it is the hard metal coating which forms the cutting edge. In fact, as the cutting edges of the blade undergo wear, the softer blade material is worn away preferentially, thereby exposing the harder metal coating on one side of the blade. In effect, the blade becomes self-sharpening in use.

The blade substrate material is typically metal and any conventional cutting blade metal having a hardness of at least about 40 Rockwell may be employed, as is apparent to those skilled in the art. An example of a suitable material is the carbon steel known as No. 1095. Spring steel is also expected to be useful. The preferred material is No. 1095 carbon steel.

The coating which is on one side only of the perforating blade of the invention is a hard metal material. Generally, this hard metallic coating should have a Rockwell hardness of at least about 50, preferably at least about 70. Examples of hard metallic materials which are, or which are expected to be, suitable for use as the blade coating in the present invention include the metal carbides such as tungsten carbide; and nickel alloys, such as the nickel alloy commercially available from Electro-Coatings, Inc. under the tradename Ny-Carb (which comprises a nickel-phosphorus matrix containing about 30 weight % of silicon carbide particles- 1 to 3 microns in size-

embedded therein). Tungsten carbide is the preferred hard metallic coating material since it generally has a hardness of over 70 Rockwell.

The term "tungsten carbide" as used herein is meant to include both tungsten carbide per se as well as tungsten carbide containing small amounts of other hard metals such as cobalt. As an example, tungsten carbide coatings are commercially available from Union Carbide Corporation which comprise cobalt in a mixture of tungsten carbides; for example, under the tradenames LW-30 (13 weight % Co - balance tungsten carbides); LW-1N30 (13 weight % Co - balance tungsten carbides); LW-1N40 (15 weight % Co - balance tungsten carbides); and LW-1N20 (11 weight % Co - balance tungsten carbides). The LW-30, LW-1N30 and LW-1N20 coatings have hardness values of 74-75, 72-73 and 71-72 Rockwell, respectively. The LW-1N30 is preferred.

The hard metal coating may be formed on the perforating blade by any convenient method. In a preferred embodiment (i.e., a chamfered, unslotted blade), the coating is formed on the flat side of the blade after sharpening as shown in Figures 5-7 of the drawings. Figure 4 is a side view of one of the teeth of the blade of Figure 3, having a hard metal coating on its flat side. Specifically, referring to Figure 5, a blade tooth 27 is shown which has a chamfered face 28 formed by edges 32 and 33 and cutting edge 30. A coating 35 (shown in exaggerated form) is provided on the flat side of the tooth 27, thereby forming a new, hard cutting edge 36.

The tip area of the blade tooth of Figure 5, before and after some wear, is schematically illustrated in Figures 6 and 7, which are exaggerated for detail, and where the same reference numerals indicate the same parts as in the other drawings. As best shown in Figure 7, as the perforating blade is used, due to the more rapid wear of the softer blade main body at 38 as compared to that of the relatively harder metal coating at 37, the blade in effect is self-sharpening.

The hard metal coating may be formed on the perforating blade by any suitable process. As an example, and in a preferred embodiment, a tungsten carbide coating may be formed by a commercially-available process of Union Carbide Corporation known as flame-plating. In this process, the coating material (tungsten carbide, with or without additives) is fired from a detonation gun at the part being coated at supersonic speeds and at very high temperatures. The process is more fully described in U.S. Patent No. 2,714,563, the disclosure of which is expressly incorporated herein by reference. Since the coating particles strike the part being coated by this process with such high speed, it may be necessary, and it is therefore preferred, to support the perforating blade teeth from the side opposite the side being coated, in order to prevent deformation of the teeth. The necessity for providing such support depends on the thickness and rigidity of the blade and the specific conditions of the flame plating operation.

The hard metal material may be coated onto the blade substrate to a thickness of from about 0.0005 to 0.0015 inch, preferably from about 0.0005 to 0.0007 inch. In the case of tungsten carbide and a blade used to cut or perforate low pressure-low density polyethylene, the tungsten carbide coating has a thickness on the order of about 0.0005 to 0.001 inch.

In addition to perforating plastic film packaging materials as discussed above, the present invention also contemplates other plastic film cutting operations, such as punching and slitting wherein the cutting instrument is coated on one side only with a hard metal coating of the types described above. In the case of punching, a circular blade is generally used which may be formed of any conventional blade-type material, such as No. 1095 carbon steel. Such blades are generally unslotted and are provided with teeth around the entire circumference of the blade. The teeth may be sharpened by beveling the inside edges thereof. When punching holes in plastic film material, such as low pressure-low density polyethylene, the useful service life of such punching blades may be extended by coating the outside, flat surface thereof with a hard metal material such as tungston carbide in the same manner as discussed above.

In addition to punching blades, slitting-type blades may be coated to extend their useful service life when slitting materials such as low pressure-low density polyethylene film. Slitting blades are used in many different applications such as forming flat films from a film tube formed by a tubular blown film extrusion process. The tube may be slit on one or both sides to provide the flat film.

In one instance, it was the practice to sharpen the slitting blades once a week when slitting conventional high pressure-low density polyethylene. When low pressure-low density polyethylene was employed in the process, it was found necessary to sharpen the slitting blades twice a day. These blades were curved and were sharpened on one edge only to provide a chamfered surface on that side. By coating the flat side of these curved blades with a hard metallic material such as tungsten carbide, using the flame-plating process described above, it was found necessary to sharpen these blades only once a week even when slitting low pressure-low density polyethylene film.

EXAMPLE 1

New 10-inch long 40-tooth unslotted blades of No. 1095 carbon steel were sharpened to provide a chamfered face on one side of each tooth. The flat side of the teeth of these blades was then coated with a LW-30 tungsten carbide to a thickness of 3 mils and a set of 5 blades was installed in a Gloucester Model 418 bag machine. The machine was operated at a line speed of 170 feet per minute and a perforating speed of 122 cycles per minute to produce produce-type bags of low pressure-low density polyethylene having a thickness of 0.5 mil. These blades produced good perforations even after 13 days of operation at which point 2 of the blades were removed and installed in a so-called wet bag line employing a Gloucester Model 418 machine and a downstream separator designed to separate and stack the bags. This line was operated at a speed of 170 feet per minute and a perforating speed of 122 cycles per minute to produce

low pressure-low density polyethylene bags having a thickness of 0.5 mil. These 2 blades produced good perforations for an additional 14 days.

EXAMPLE 2

New 40-tooth unslotted perforating blades, 10 inches long and composed of No. 1095 carbon steel and having a hardness of 46-48 Rockwell in the teeth area, were installed in a bag-making line using a Gloucester Engineering Model No. 418 bag-making machine. The line was operated to make low pressure-low density polyethylene produce-type bags having a thickness of 0.5 mil. The line speed was 170 feed per minute and the perforating cycle was 122 cycles per minute. These blades became too dull to provide good perforations after only 24 hours of use. The blades were removed from the machine and the tips of some of the teeth were observed to have rolled back thereby dulling those teeth.

EXAMPLE 3

A Ny-Carb coating (30 weight % of 1-3 micron particles of silicon carbide embedded in a nickel-phosphorus matrix) was coated onto both sides of new 10-inch long, 40-tooth slotted perforating blades formed of No. 1095 carbon steel and having slots 0.030 inch wide between each tooth, by a conventional plating process. The Ny-Carb coating had a hardness of 50-68 Rockwell and a thickness of 3 mils. These blades were then installed in the same type of Gloucester bag-making line as used in Example 1. The line was operated

at 253 feet per minute and at a perforating speed of 184 cycles per minute to produce the same type of low pressure-low density polyethylene produce-type bags as in Example 1 having a thickness of 0.5 mil. Right at the start of operation, it was noticed that the perforations were not of good quality and the blades after 21 hours became too dull and were removed.

A second set of the same type of perforating blades was coated on both sides with the same Ny-Carb coating by the same plating technique to a thickness of 3 mils, and a hardness of 60-68 Rockwell and placed in the same bag-making line and then used to make the same type of low pressure-low density polyethylene bags. This set of blades lasted only 20 hours before becoming dull enough to warrant removal from the machine.

EXAMPLE 4

Two sets of new 10-inch long, 50 -tooth perforating blades formed of No. 1095 carbon steel were spray-coated on both sides with a conventional aerosol-type Teflon spray and left to dry for six hours. The blades were coated again on both sides with the same Teflon spray and left to dry overnight. The thickness of the Teflon coating was 0.5 mil. One set of blades was installed in a bag-making line using a Gloucester Model No. 418 machine which was then operated at a line speed of 170 feet per minute and at a perforating speed of 122 cycles per minute to make low pressure-low density polyethylene bags having a thickness of 0.5 mil. The blades were removed after 26 hours when the perforations

became poor. The second set of teflon-coated blades, coated in the same manner, lasted an additional 4 hours in the same line when operated under substantially the same conditions.

EXAMPLE 5

A set of new, 10-inch long 50-tooth slotted (each slot being 0.035-0.040 inch wide) perforating blades formed of No. 1095 carbon steel were dip-coated with Teflon 8-403 to a thickness of 0.2-0.3 mil followed by baking. The resulting blades were installed in a bag-making line using a Gloucester Model No. 418 machine and the line was operated at a speed of 170 feet per minute and a perforating speed of 122 cycles per minute to produce low pressure-low density polyethylene bags. The blades were removed after about 4 days due to poor perforations.

EXAMPLE 6

The set of blades of Example 2 were resharpened after removal and re-installed in the bag-making line which was again operated under substantially the same conditions as in Example 2. The resharpened blades failed to give good perforations after only 8 to 24 hours.

It is apparent to those skilled in the art that various other changes and modifications may be made in the present invention without departing from the spirit and scope thereof. It is the intention not to be limited by the foregoing description, but rather only by the scope of the claims appended hereto.

WHAT IS CLAIMED IS:

1. A process for cutting a plastic film which comprises contacting the plastic film with a metal knife blade which has a coating, on only one side thereof, of a hard metallic substance having a hardness of at least about 50 Rockwell, preferably about 70 Rockwell.

2. The process of Claim 1, wherein the edge of one side of said knife blade is beveled, wherein the other side of said knife blade is flat and wherein said coating is on said flat side only.

3. The process of Claim 1 or 2, wherein said metallic substance comprises tungsten carbide.

4. The process according to any one of the preceding claims, wherein said plastic film is composed of low pressure-low density polyethylene.

5. In a process for perforating a plastic film with a perforating blade having teeth along one edge thereof which comprises forcing the teeth of said perforating blade through said plastic film/the improvement comprising using a perforating blade one side only of which is coated with a hard metallic substance having a hardness of at least about 50 Rockwell, preferably of at least about 70 Rockwell.

6. The process of Claim 5, wherein the edges on one side of the teeth of said perforating blade are beveled, wherein the other side of said teeth is flat and wherein said coating is on said flat side only.

7. The process of Claim 6 or 7, wherein said metallic substance comprises tungsten carbide.

8. The process according to any one of the Claims 5 to 7, wherein said plastic film is composed of low pressure-low density polyethylene.

9. The process according to any one of the claims 5 to 8, wherein said blade has slots between adjacent teeth.

10. In a process for making continuous strips of interconnected and separable packaging bags composed of low pressure-low density polyethylene film which comprises forming a tube of low pressure-low density polyethylene film and heat-sealing said tube across its width at periodic longitudinally-spaced intervals and perforating said tube at similar intervals with a metal perforating knife having a plurality of teeth along one edge thereof, the improvement comprising using a perforating blade whose teeth are coated on one side only with a hard metallic substance having a hardness of at least about 50 Rockwell, preferably about 70 Rockwell.

11. The process of Claim 10, wherein the edges of one side of said teeth are beveled, wherein the other side of said teeth is flat and wherein said coating is on said flat side only.

12. The process of Claim 10 or 11, wherein said metallic substance comprises tungsten carbide.

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Fig.1.

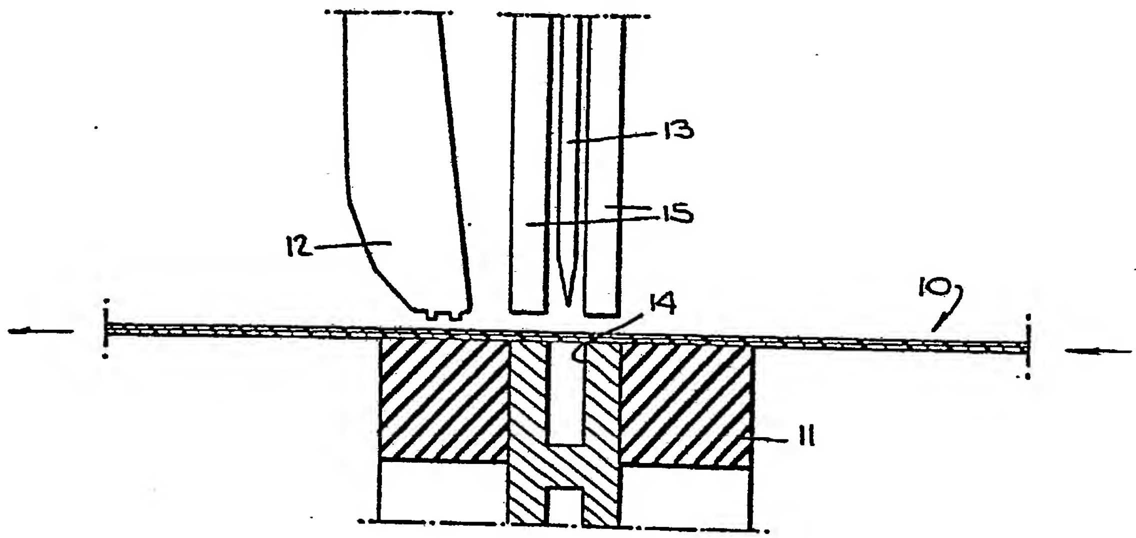


Fig.2.

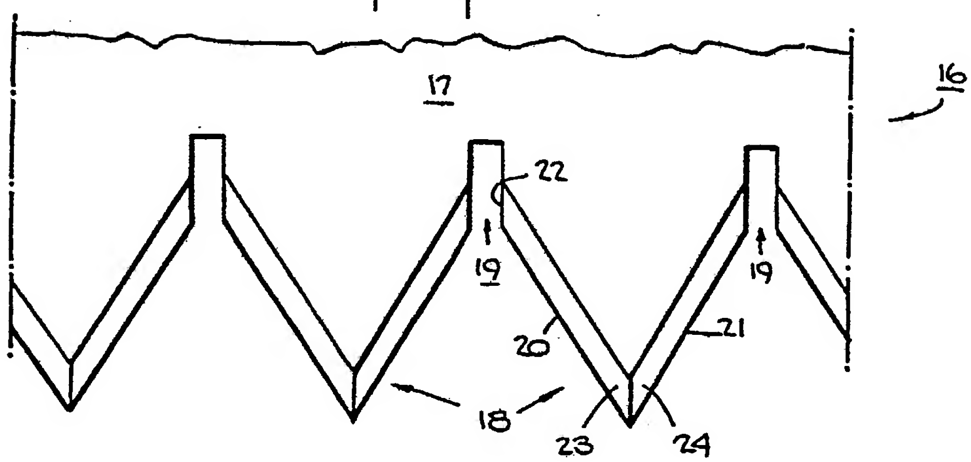
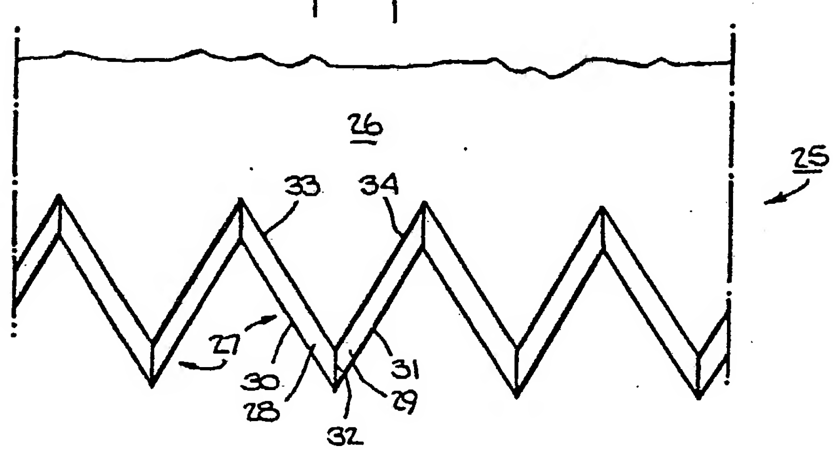


Fig.3.



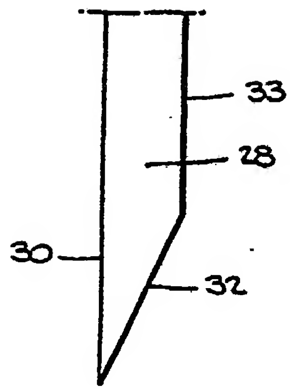


Fig.4.

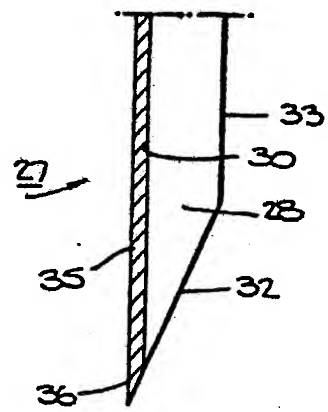


Fig.5.

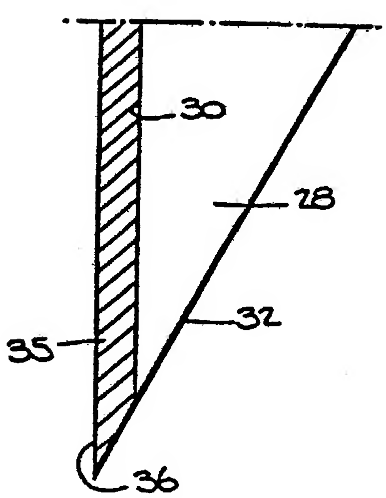


Fig.6.

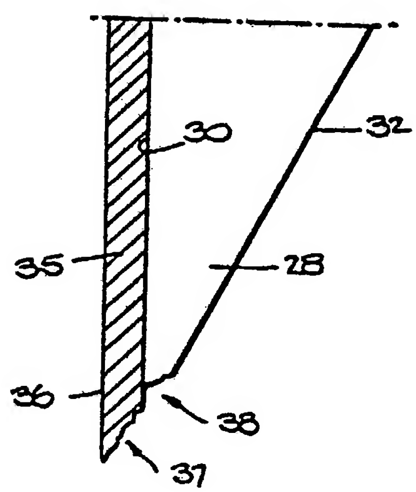


Fig.7.

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Application number

European Patent Office

EUROPEAN SEARCH REPORT

EP 81 10 4658.0

DOCUMENTS CONSIDERED TO BE RELEVANT			CLASSIFICATION OF THE APPLICATION (Int. Cl.³)
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	
	DE - B - 2 107 043 (H. LEHMACHER) * column 5, lines 3 to 6 *	1-3, 5	B 29 C 17/14 B 29 C 24/02 B 31 B 23/14
	DE - A1 - 2 533 471 (GREINER GMBH & CO.) * claim 5 *	5,10	
D	US - A - 4 064 776 (C.R. WALITALO et al.) * claim 1 *	5	TECHNICAL FIELDS SEARCHED (Int. Cl.³)
A	US - A - 4 019 947 (D.K. STOCK et al.) * abstract *		B 29 C 17/00 B 29 C 24/00 B 29 C 27/06 B 31 B 23/00
D,A	US - A - 3 975 891 (R.E. GUNTHER) * claim 1 *		

CATEGORY OF CITED DOCUMENTS

X: particularly relevant
A: technological background
O: non-written disclosure
P: intermediate document
T: theory or principle underlying the invention
E: conflicting application
D: document cited in the application
L: citation for other reasons

&: member of the same patent family, corresponding document

X The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Berlin	12-08-1981	BITTNER

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